Comparisons of wind speed retrievals from an airborne microwave radiometer (AMPR) with satellite-based observations during the OLYMPEX/RADEX field campaign

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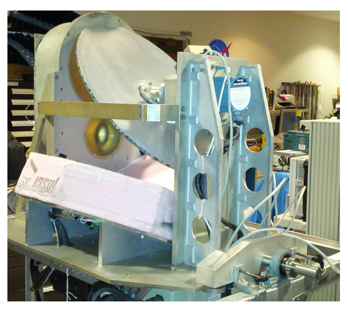
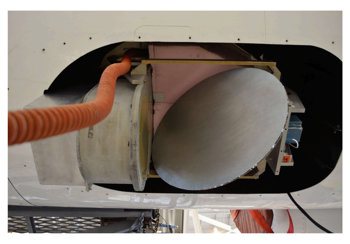
1. Introduction

AMPR is an airborne instrument that flew aboard the NASA ER-2 during the OLYMPEX/RADEX field campaign in late 2015. This poster's goal is to explore how well the instrument can retrieve near-surface wind speed over the ocean.

AMPR Instrument Description:

- Passive microwave radiometer – Retrieve surface emission, cloud liquid water, precipitation rate, water vapor, ice scattering, wind speed, and more
- Four frequencies - 10.7, 19.35, 37.1, 85.5 GHz, with 2 variable polarization channels apiece (Channel A: V -> H and Channel B: H -> V)
- Cross-track scanning, polarization state varies according to scan angle, H & V deconvolution possible





2. Retrieval Methodology

Multi-Linear Regression Model(s)

- Model for Columnar Water Vapor (V in mm):

$$V\ (mm) = a_0 + a_1{*}T_{B10v} + a_2{*}T_{B10h} + a_3{*}\ln(290-T_{B19v}) + a_4{*}\ln(290-T_{B19h}) + a_5{*}\ln(290-T_{B37v}) + a_6{*}\ln(290-T_{B37h}) \quad (1)$$

- Model for Columnar Cloud Liquid Water (L in mm):

$$L\ (mm) = a_0 + a_1{*}\ln(290-T_{B19v}) + a_2{*}\ln(290-T_{B19h}) + a_3{*}\ln(295-T_{B85v}) + a_4{*}\ln(295-T_{B85h}) \quad (2)$$

- Model for Surface Wind Speed (WS in m/s):

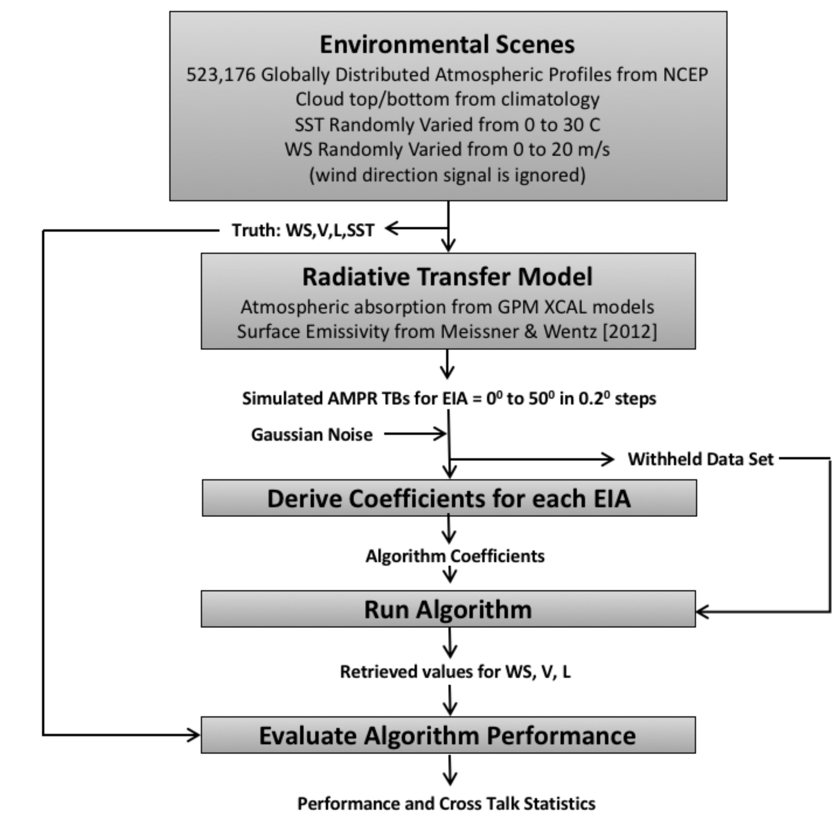
$$WS\ (m/s) = a_0 + a_1{*}T_{B10v} + a_2{*}T_{B10h} + a_3{*}\ln(290-T_{B19v}) + a_4{*}\ln(290-T_{B19h}) + a_5{*}T^2_{B10v} + a_6{*}T^2_{B10h} + a_7{*}T_{B10v}{*}T_{B10h} + a_8{*}SST \quad (3)$$

Where, $T_{Bnv,h}$ = Measured T_B for n GHz v,h-polarization channels
SST = Sea Surface Temperature in Kelvin (a priori value needed)
a_n coefficients are polynomial functions of the incidence angle*

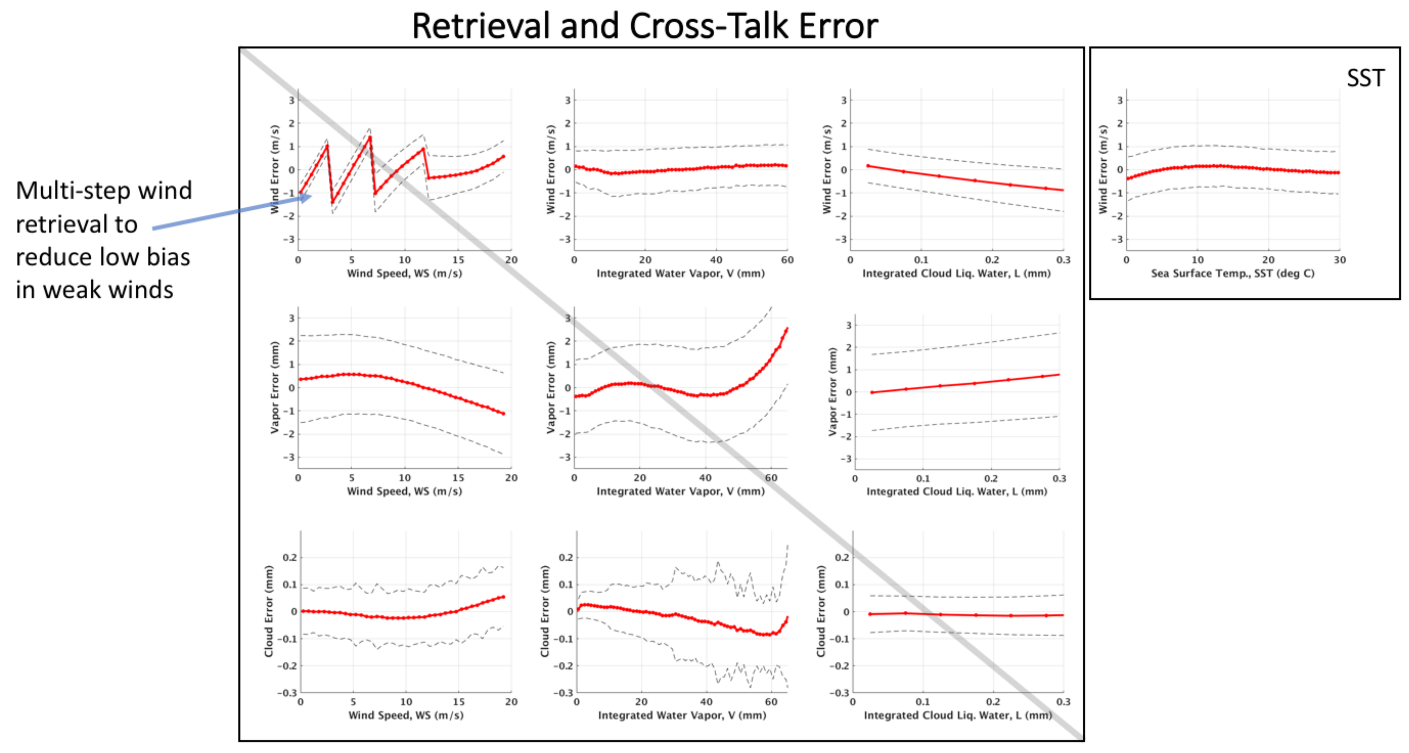
The WS retrieval is further improved by generating 'a' coefficients for different range of wind speeds, e.g. WS<=3, WS>3<=7, WS>7<=12 & WS>12 .

(*AMPR is a cross-track scanner and the observation incidence angle varies between 0^0 to 45^0)

Coefficient Derivation & Testing

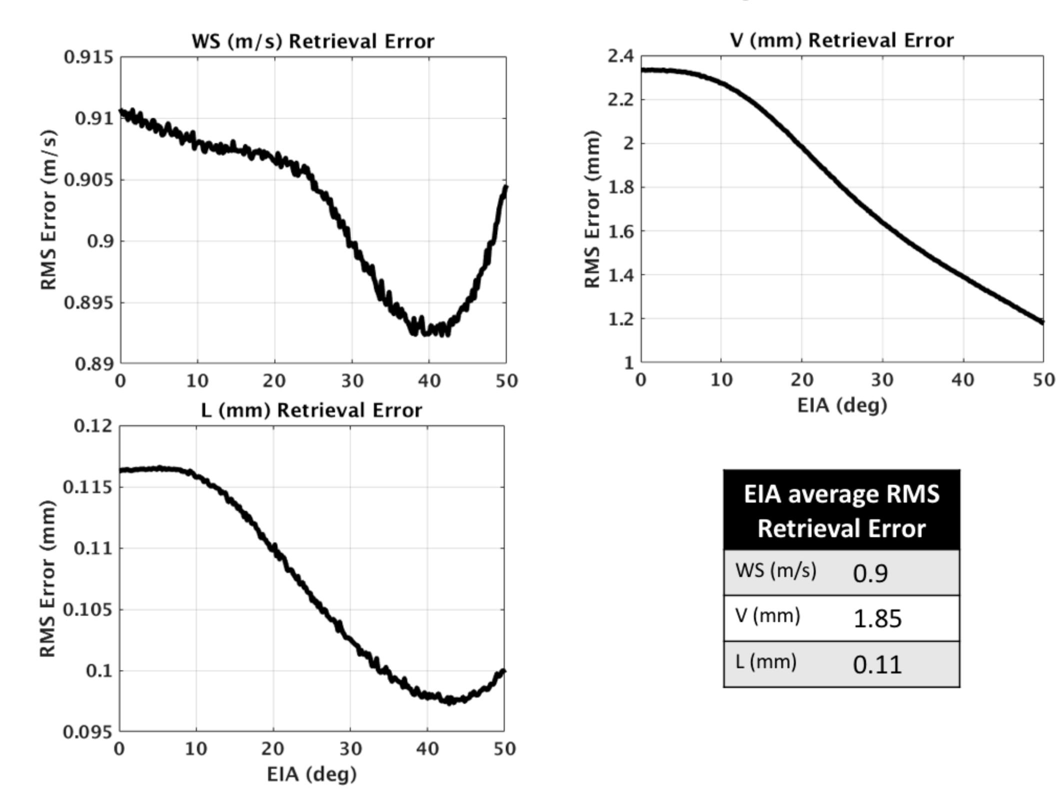


Retrieval and Cross-Talk Error



Errors are averaged over all Earth Incidence Angles (EIA) between 0 to 50 deg

RMS Retrieval Error vs. Earth Incidence Angle (EIA)



EIA average RMS Retrieval Error	
WS (m/s)	0.9
V (mm)	1.85
L (mm)	0.11

3. Initial Results

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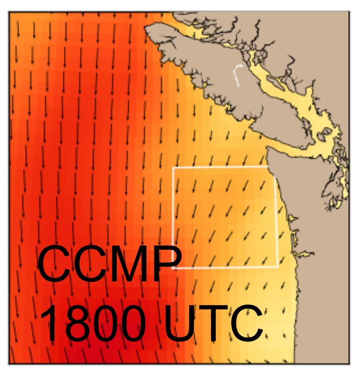
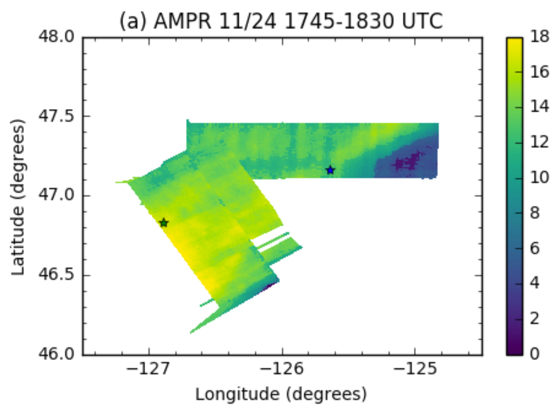
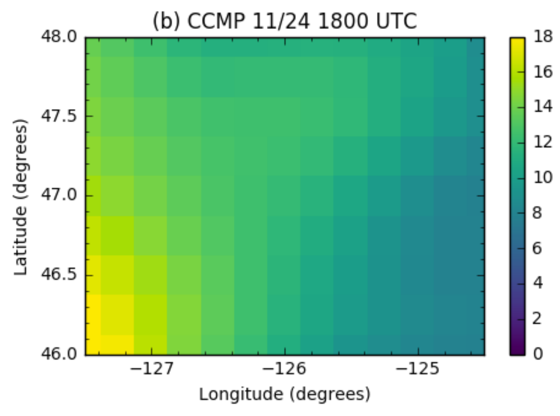
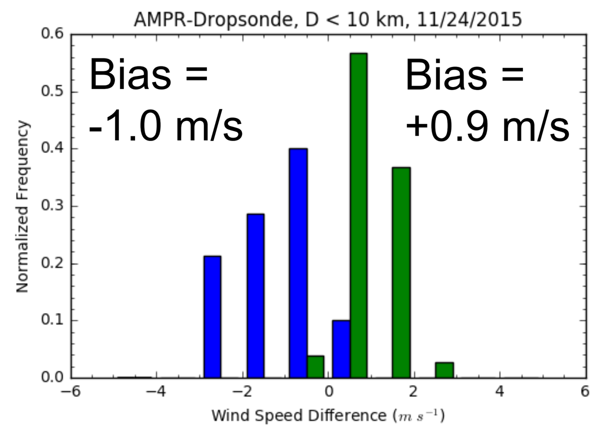
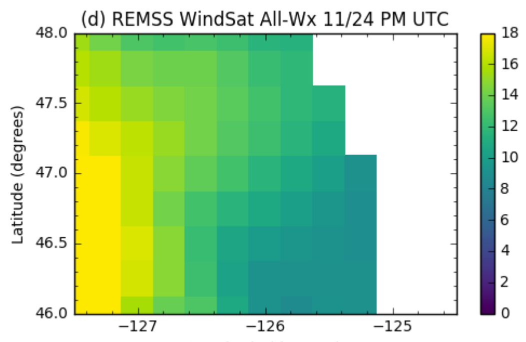






- Slantwise gradient captured by AMPR
- Range of domain wind speeds captured
- Good agreement with nearby dropsondes





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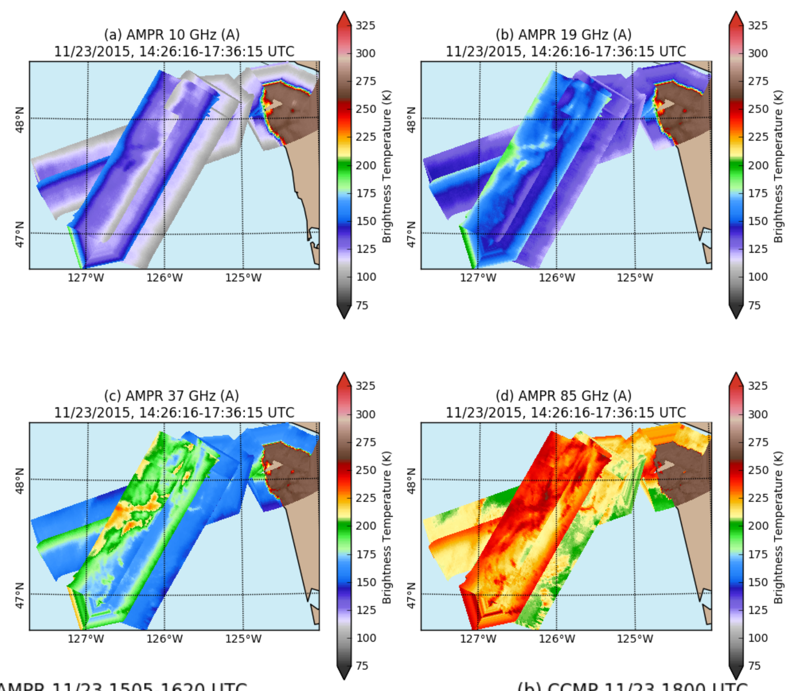
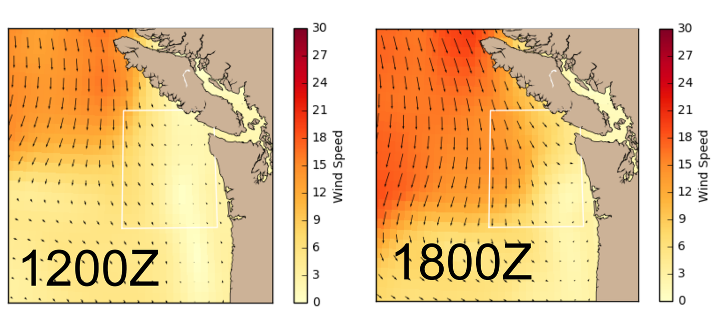
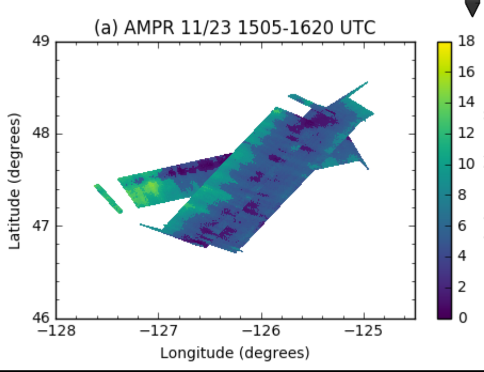
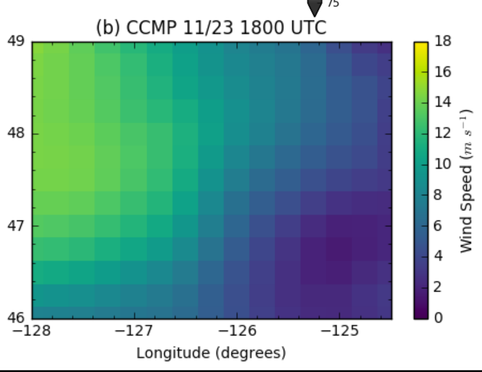




- Frontal system moving into domain from NW
- Evidence for motion of wind speed gradient
- Retrieval noisy at lower wind speeds, further tuning required.





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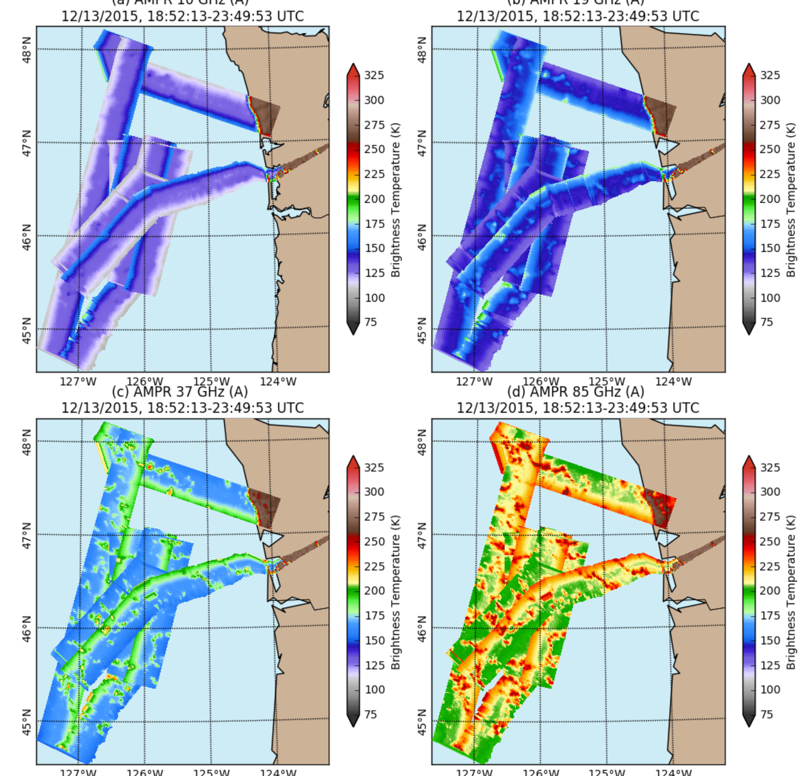
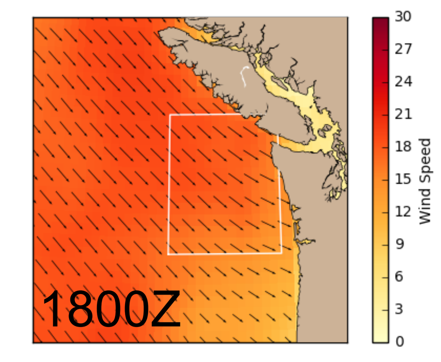
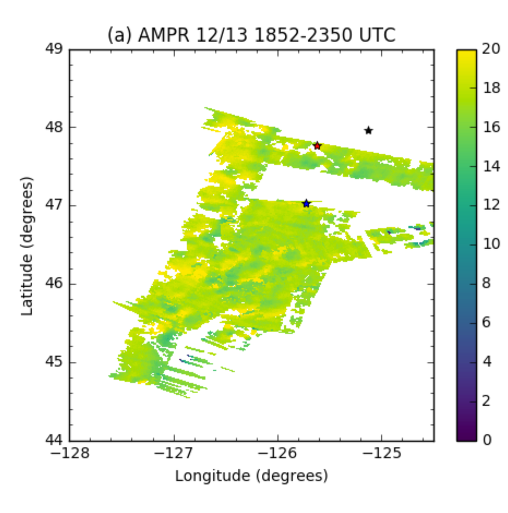
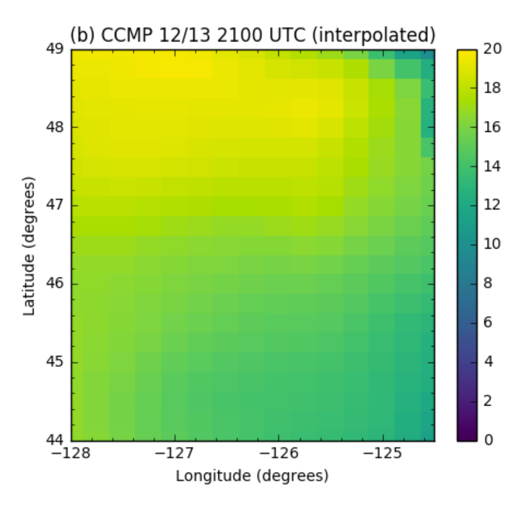
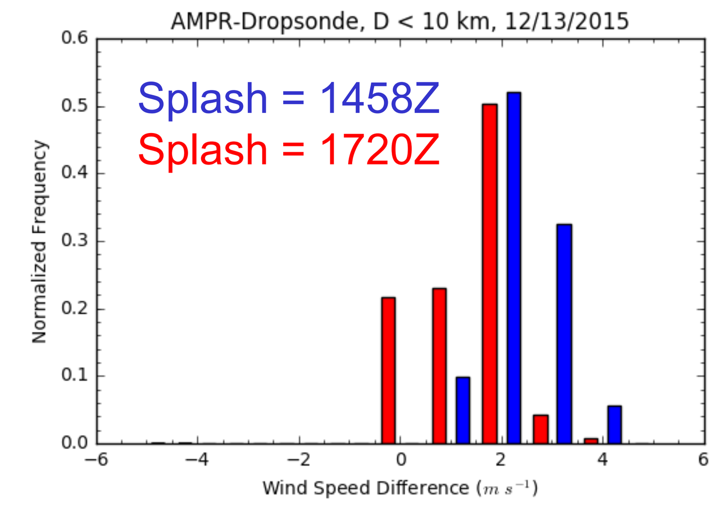


- Scattered, shallow post-frontal convection
- Evidence for small-scale cold pools outside precip?
- Dropsondes > 1 h from AMPR; however, closest one within 1.2 m/s









4. Summary

- AMPR cross-track scanner leads to polarization mixing and variable incidence angles, requiring the use of a customized wind speed retrieval algorithm.
- Population of atmospheric model profiles, combined with radiative transfer model, used to develop empirical algorithm to estimate wind speed, cloud liquid water, water vapor, etc. based on deconvolved AMPR polarized TBs.
- Initial results promising, though further tuning is required. Results showcase potential spatial resolution advantages of AMPR (10-GHz footprint < 2 km), as well as ability to capture evolving weather.

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